RADIANT SYSTEMS ENTERPRISES, INC

ALL ASPECTS OF

THE RADIANT HEATING

PROCESS AND ENERGY

MANAGEMENT PRODUCTS.

Welcome

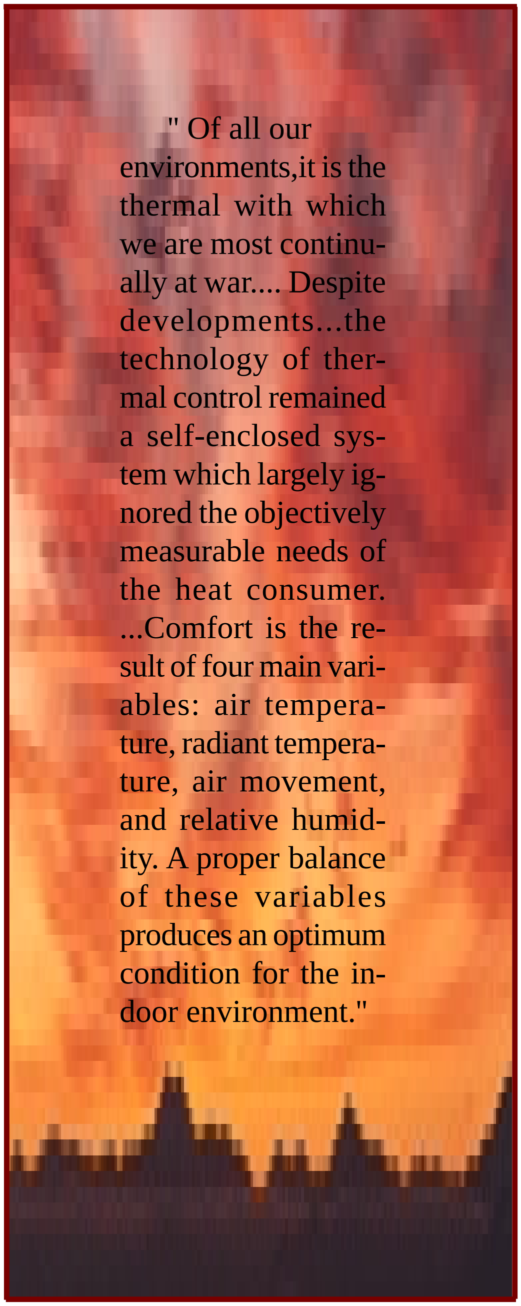
Let's explore together the healthy, comfortable, low maintenance and energy efficient world of Radiant Heating

Could any other heating system you know of make this area "toasty"comfortable and draft-free in 20 minutes or less on a really cold day and still be very energy efficient?

An installation of cove & wall radiant heat panels

Introducing

Radiant Heat



" Of all our environments,it is the thermal with which we are most continually at war.... Despite developments...the technology of thermal control remained a self-enclosed system which largely ignored the objectively measurable needs of the heat consumer. ...Comfort is the result of four main variables: air temperature, radiant temperature, air movement, and relative humidity. A proper balance of these variables produces an optimum condition for the indoor environment."

"The four methods of heat transfer are outlined as follows:

Conduction is the manner in which heat is transferred through the physical contact of two objects (feet on a cold floor), an object and a liquid (food in hot water), and to a certain extent, an object and the still atmosphere.

Convection is the way in which heat is lost or gained by contact with moving air and, together with conduction, accounts for about two-fifths of the release of the body at rest.

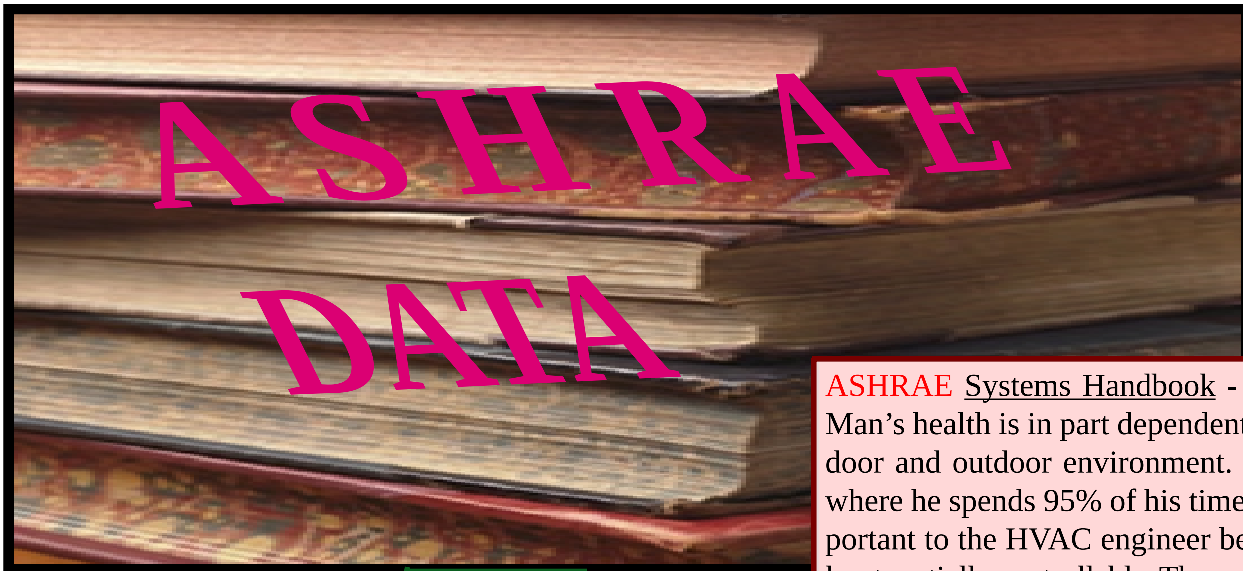
Evaporation is heat loss through sweating. It represents a change, in comparison with other methods of dissipation, of almost radical magnitude and is the controlling factor under high temperature conditions. The final factor -

Radiation is the method by which heat is transmitted directly between objects that are separated in space. Like light, radiant heat is diffussed in straight lines and has virtually no effect on the atmospheric medium through which it passes. The sun is an excellent source of radiant heat, and accounts for the fact that we may feel comfortably warm in our shirt-sleeves when exposed to brilliant sunlight in winter, although the surrounding air is quite cold. The human skin is ideally suited for absorbing this radiant heat, being 99 per cent emissive - and absorptive - of the infra-red rays which make up the radiant band." (Wright -HEAT)

"Comfort is the result of four main variables:
1) air temperature, **2)** radiant temperature,
3) air movement, and **4)** relative humidity. A proper balance of these four variables produces an optimum condition for the indoor environment."

PLUS,

It appears that optimum indoor environmental conditioning is primarily a matter of regulating heat loss.

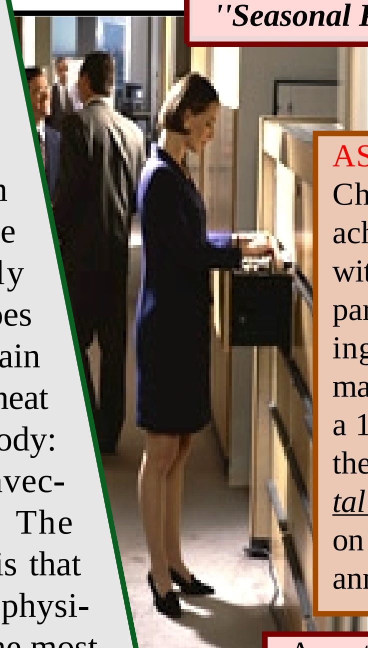


ASHRAE <u>Systems Handbook</u> - Chapter 8. " Man's health is in part dependent upon his indoor and outdoor environment. The indoors, where he spends 95% of his time, is more important to the HVAC engineer because it is at least partially controllable. The main difference between in door and outdoor atmospheres is in concentration of bacteria and viruses; the concentration is very small outdoors, while greater numbers indoors create greater possibility for transmission among people." Follows a detailed section on the subject :

"Seasonal Patterns of Illness and Death"

ASHRAE <u>Handbook</u>, Chapter 8

"In search for the correct conditions which will be compatible with the physiological demands of the human body, no system [of heating] can be rated as completely satisfactory which does not satisy the three main factors controlling the heat loss from the human body: namely, radiation, convection and evaporation. The greatest of these losses is that due to radiation, which physiologically appears to be the most important. In spite of this, however, it rarely receives consideration in any of the air conditioning systems and is ignored entirely in all types of warm air or convection heat systems. We must conclude therefore that the usual methods of heating and cooling are basically inadequate, since no system can produce conditions compatible with the physiological demands of the human body, unless the radiation losses are satisfied in some way."



ASHRAE <u>Equipment Handbook</u> - Chapter 29 "Quantitative data on achievable energy savings possible with infrared heating systems as compared to other types of comfort heating systems is sketchy due to the many interacting variables. However, a 1973 Ad Hoc committee report by the *<u>New York State Interdepartmental Fuel and Energy Committee</u>* based on investigations on New York claims annual fuel savings as high as 50%"

An article recently written by two engineers on the *<u>Energy Conservation Committee</u>*, published in the July 1996, **ASHRAE JOURNAL**, includes data showing ***<u>radiant wall panels</u>*** consumed **33%** less electricity than heat pumps and **52%** less electricity than standard convection baseboards.

Engineering research supplies

data & definite answers

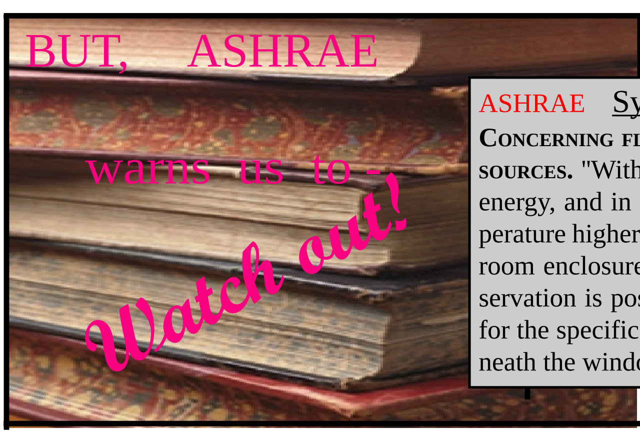
ASHRAE Systems Handbook - Chapter 19 " ... for total building heating... [radiant heating] produces a most effective and efficient means of utilizing energy."

Chapter 29 - **Energy Conservation** "[Infrared] heaters may be used for heating of a large area or an entire building with high efficiency and a very substantial energy saving compared to a conventional heating system. They transfer energy by radiation directly to whatever will absorb the energy, and this absorption results in a heating effect....Hardly any energy is lost between the radiating surface and target area because air is a poor absorber of infrared energy. As personnel, floors, and objects in the primary radiation pattern are warmed by the infrared energy, they tend to reradiate heat or lose it by convection.... Another conservation advantage of radiant heat is that, just as with a light bulb, it can be turned off when not needed. When turned on again, radiant heat becomes fully effective in minutes.... Since human comfort is determined by the average of mean radiant and dry-bulb [ambient]temperature...dry-bulb temperature for a given comfort level will be lower when heating with radiation. Heat loss to ventilating air and transmission (especially if care is excercised to make certain radiation is not focused on outside walls [and reflective surfaces and reflective insulations are strategically utilized]) will be correspondingly lower, as will energy consumption."

Controls " thermostatic control of infrared heating requires careful consideration od sensor and location...The most desirable cycling rate for thermostats controlling infrared heaters has not yet been fully... defined."

NOTE: Our radiant energy control product was not operational at the time of this publication. After years of carefully field testing ***our control product*** completely addressed all ASHRAE requirements for an energy management control system.

ASHRAE Systems Handbook - Chapter 19. " Usually, the environment in infrared comfort heating is characterized by existence together of a high temperature, strongly directional, radiant field created by the infrared heaters and a low temperature, essentially uniform, radiant field represented by the surrounding or enclosing surfaces. In indoor installations, air temperature typically will be lower than with conventional convective heating. Actually, this temperature is a derived quantity (as in radiant panel heating) which is dictated by heat balance between body absorption of high temperature radiation and heat loss from the body surface to cooler air and enclosure surfaces, as needed for a state of comfort. ... key factors that determine the effectiveness of radiant heating are reflectance and absorption of a man's skin and clothing surfaces for the color temperature of the radiating source..."[as well as the reflectiveness and absorption of room and insulation surfaces.] ASHRAE Fundamentals ... Chapter 8 "A knowledge of both the optical and thermal properties of the human skin is necessary to understand the effects of infrared radiation in: 1) producing changes in skin temperature and skin blood flow...since the human skin has variable thickness over different parts of the body...[this issue] concerns skin reflectance and transmittance; and 2) evoking sensations of temperature and comfort ... transmission of radiation into skin. ... [the designer] must study the skin and its interaction with ... infrared radiation [to totally satisfy comfort requirements]"



ASHRAE Systems Handbook - Chapter 19.
Concerning floor and implying ceiling radiant heating sources. "Within these areas, the floor absorbs most of the energy, and in the process is heated to an equilibrium temperature higher than that of the ambient air and the unheated room enclosure surfaces. Therefore, very little energy conservation is possible. ...The ***best place*** for a [radiant] panel for the specific purpose of neutralizing radiation loss, is beneath the window itself ...and outside walls."

Before going into the details of energy efficiency, installation locations, and maintenance, etc., Let's look at some salient factors related to the radiant heating process that makes the concept very desirable for people's comfort within the indoor environment.

Health and air quality , are considerations, relating directly to the unique value of the radiant heating process. - **Could you elaborate?**

Since the process of tempering the indoor environment with radiant warmth does not require the use of air transfer ducts, that attract dust, pollen, dirt, and bacteria, the quality of the indoor air is vastly improved a vital factor, often undervalued or ignored in the designing process of a project.

Architects and designers are becoming increasingly aware of the legal implications involved in specifying use of forced air systems and their relation to air pollution, air bacteria levels, and dirt and pollen contaminant levels in air ducts and plenums, especially when designing structures for elderly citizens in assisted living or nursing home projects. Recent articles have been devoted to this subject. Let's see why this is so important.

Noting that the radiant heating process is a "natural" heating process since it simulates the radiant warming process of the sun, individuals are comforted by radiant warmth either through direct "shine" exposure or by re-radiation from surrounding objects.

This means people are comfortable when in an environment of a sufficient quantity of radiant energy **or** as ASHRAE puts it when the "mean radiant temperature" is increased to *off set* cold radiating surfaces, emanating from windows or outside walls. The higher radiant temperature the lower the ambient air temperature for comfort.

The secret to energy conservation with radiant cove or wall panel heating is, a lower ambient temperature with a **higher radiant temperature coefficient** and a **well developed energy management controller.** Better comfort, less fuel consumption and significantly lower energy costs.

BUT,

- it is important to note that while, a high radiant environment,(like the sun)or increasing the *mean radiant temperature*, also destroys many harmful bacteria and improves the air quality of the environment, a factor not to be ignored!

Another consideration of the radiant heating process, the fact that warmth is achieved without passing air through ducts or water-type humidifiers, is extremely important to people who are sensitive to the effects on their health of poor air quality. Ducts and humidifiers are prime locations for many types of bacteria.

Pollution from gas furnace combustion, dirty ducts and contaminated water in plenum humidifiers, are directly linked to the health problems confronting individuals, especially when turning "on" their heating system for the first time of the season. Individuals have experienced "mysterious" respiratory and other more serious consequences.

Truly fine heating is **the <u>most</u>** important aspect of the climate conditioning process for every project. Heating is in use most days of the year. It is annoying and irritating to be drafty, chilly and uncomfortable during the heating days.

Health problems in hotels, hospitals, nursing homes, and schools that seem unexplainable, other than from bacteria in air ducts or heat exchangers and/ or polluting gases. **BUT,** poor indoor air quality relates to discomfort, stress, and disease for many people.

Heating *ought to be* the best of comfort and energy efficiency that is available.

Ergonomists study environmental conditions and how they relate to people stress, health, and productivity. I met through the internet, an engineer who has a 40 year internationally recognized reputation in all phases of commercial, industrial,institutional, and industrial airdistribution and air quality design. He has been called upon repeatedly to resolve serious, health related, in-door air quality problems working mainly with ergonomists. William McMichael has given permission for you to use his e-mail address for any of your air quality questions.

His e-mail address is - **(wmcmichael@ns.gemlink.com)** He could offer you some excellent support for your evaluation process from an air quality viewpoint. Health officials are becoming increasingly aware that indoor air quality is a serious consideration in the selection of a heating system, especially if the elderly patients are going to occupy the building. Our design process is non-polluting, reduces air flow to minimum code requirements, producing better energy efficiency, cleaner air quality, and improved comfort!

Our products forward this goal ***plus*** maintain a superior air quality.

Thermal characteristics of the human body and how comfort and radiant heating relate, has interested many writers. Mr. Edward T. Hall a former Northwestern University professor, wrote inthe early 1980's: "Architectural Implications of the Thermal Qualities of the Human Skin"

> *"All over the world man is facing a serious energy crisis. Yet in the United States and most of Western Europe energy continues to be wasted in face of belated recognition of this crisis. It is now imperative that man begin to think...*
>
> *Until now, the design of heating and air conditioning systems has been the responsibility of the engineer. The fact that the engineer's solutions were less than satisfactory when measured against human comfort scales was considered the price that one had to pay for progress. The complaints about aging, dried-out skin and cracked mucous membranes and various kinds of malaise associated with hot and cold air systems were brushed aside...the engineers simply did not - if they took these complaints seriously - know how to deal with them. ...*
>
> *Western man, has become object oriented at the expense of genuine concern for human beings... how can we make the switch from heating buildings to heating people, and what does this imply. ...*
>
> *This subject has concerned me for some years, not only because most buildings are heated (and cooled) badly but because present methods are wasteful of our dwindling resources. ... Heating a person is not the same thing as heating a house. ...*
>
> *...thermal satisfaction can be found in little known, recently discovered qualities of the human skin... It is therefore possible to calculate the emissive index of... materials so that all materials have not only relative emissive values but an absolute value as well... It will be noted that human skin (regardless of color) is at the top of the list. ...*
>
> *Thinking in terms of heating people in enclosed spaces, it would be possible to conceive of low-heat mass systems that would be activated as soon as someone enters a room... without the expense of heating the air.. or maintaining the heat when the room was not occupied... conventional hot water radiant systems take too long to res pond... and they are sometimes experienced as quite uncomfortable (cold and clammy)... The reason hot air systems are unsatisfactory when looked at in terms of human physiology is that a) the emissivity index of air is virtually nil ... ,b) ...the radiant characteristics of the skin are unused.*
>
> *At this point it is essential to urge engineers to design systems with a low thermal mass (so that they can be brought to temperature very quickly) which will exploit the heat gathering capabilities of the human skin."*

Addressing the importance of radiant heating and the naturalness of the human body to respond to the characteristics of a radiant environment, relates directly to people's comfort and health. Quality comfort is an essential for productivity, reducing stress loads and for providing a relaxed atmosphere in the home and the work place. Indoor air quality is also extremely important to the well being of the family or employees.

Health officials are increasingly aware that indoor air quality and non-polluting systems are meaningful criteria in selecting a heating program, especially if elderly clients are in consideration, such as nursing home, apartment, motel or assisted residence projects.

From a recent article, "Let's *Heat People Instead of Houses*", Dr. Hall writes;

> *"What if it were possible to cut heating costs to a fraction of the current rate... without spending billions of dollars for solar retrofits and insulation and if the final results would be a healthier, more satisfying heat...? In this case, the problem under discussion is the transaction between human beings and a variety of heat sources.*
>
> *There is an abundance of data on the thermal requirements of heating buildings and none on heating people. We heat buildings in order to heat people (and that job is often done rather badly). ... There is a way to heat people that ... dates back more than 100 million years to the time when mankind's ancestors were ectotherms and lay in the sun to get warm...Few people are used to thinking in terms of radiant heat, nor are they familiar with its basic principles.*
>
> *The major difference between radiant and ambient heat is that the ambient system heats everything to the same temperature, and radiant heat (infrared), operating on entirely different principles, heats differentially according to the capacity of a material to absorb infrared. This means that if it is necessary to heat the air and everything else in the house in order to heat people, much more energy is required than if you only have to heat the people. ... As it happens, human beings are ideally suited to a radiant system - after all, mankind evolved over hundreds of millions of years in a world heated by radiant energy. ...*
>
> *Would people be healthier if they were heated only with radiant heat? It appears they would because there would be no problem from dried-out mucous membranes, which crack and allow bacteria and viruses to enter the blood stream. Paintings and furniture would certainly be better preserved.*
>
> *I believe that it would be possible to live very comfortably on at least one third of the energy we now consume. ..."*

Mr. **Henry Wright** wrote extensively on the effect of the radiant comfort process to people working in various activity levels in the same environment some years ago, but I have not read anything more thorough on the subject.

> "Despite developments that made it possible to condition a building of any size, in virtually any part of the globe, the technology of thermal control remained a self-enclosed system which largely ignored the objectively measurable needs of the heat consumer. ... With our present knowledge of people's unique thermal needs, and with the technology at our command for serving them, it has become essential and possible, to create an environment in which everyone... can be comfortable. ...
>
> The most striking fact about the thermal environment is its discontinuity in relation to our physical activities. Winter, especially, is a series of thermal shocks to which we are constantly adjusting. ... The body is comfortable when this thermal exchange between itself and the environment is approximately in equilibrium. ...it is evident that conditioning the thermal environment is primarily a matter of regulating heat loss. ... ''comfort' is the resultant of four main variables: air temperature, radiant temperature, air movement, and relative humidity. ...A thermometer registers air temperature rather than comfort. All of us have experienced times when it indicates that we should be warm, although we are actually chilly. ...

> The problem is complicated by the fact that we many be comfortable at a given temperature while sitting, but too warm at the same temperature if we are moving about or working. ... One of the goals of thermal engineering is the creation of a broad ‘comfort zone’ to permit such a wide latitude of individual activity, either in series for one person, or simultaneously for many. ... Thus the ideal comfort condition, one that is elastic enough to accommodate a broad range of activities without thermal stress, is achieved by keeping air temperature, air movement and humidity down, radiant temperature up. ...
>
> Radiant heat,...,heats surroundings and people directly ... introduces the concept of heating occupants instead of air. The panels are primarily effective in neutralizing radiant heat loss from the body, and as soon as walls are heated above air temperature they become low temperature convectors. ... The heat-reflectant surface mirrors virtually all of the radiant waves striking it. ... heat (energy) is almost completely utilized in warming people rather than walls and air.”

The original publication is no longer in print. I am indebted to their in-depth research.

Their findings seem to have eluded some engineers and architects.

Architects and designers are becoming very aware of the legal implications that might involve the specifying and use of forced air systems as related to indoor air pollution. This condition presents an impossible situation to live or work in for many people.

Without being too repetitious -

The **radiant heating process** provides warm comfort without passing air through ducts or by the necessary use of water-type humidifiers, *extremely* important to people sensitive to the effects of poor air quality and their health. Ducts and humidifiers breed many types of bacteria. Pollution from heating gas combustion, dirt build up in ducts and contaminated water in heat exchangers are directly linked to the health problems. Thes often occur when turning “ on” a heating system for the first time of the season. Groups and individuals have experienced “*mysterious*” respiratory or other serious problems in hotels, hospitals, and schools.These are seemly unexplainable other than they are caused by bacteria from ducts or heat exchangers and/or polluting gases. Almost all people are affected adversely by poor indoor air quality, causing unwanted stress and discomfort. ***Again -*** research substantiates that air quality is extremely important to the employees’ productivity and stress reduction. When people comfort and a healthy air quality is an important consideration, the radiant heating process is an definite factor contributing to a relaxed, oder controlled, and healthful "quality of living" environment.

- Another element that is most important to the radiant heating process.

RADIANT SYSTEMS ENTERPRISES

INSULATION

LET'S COME IN OUT OF THE DARK

Some interesting data has recently been developed that might surprise you regarding traditional concepts of the insulating process. This research conflicts with the present practices and thinking promoted by insulation manufacturers and builders, The results are interesting and will help us understand insulation better and begin to lead us out of the dark on this issue and shed **light on enhancement implications for the radiant heating process.**

The uniqueness of the radiant comfort, the blending of the panels emitting radiant energy and raising of the radiant temperature of the environment vs. raising the ambient air temperature, combined with the inclusion of the energy management control product for energy efficiency places a special importance on the value and character of insulation for system effectiveness.

Dr. Jay McGrew, President of *Applied Science & Engineering Corporation*, wrote an article on the value of insulation vs. heat loss. His observations are pertinent to the radiant heating picture.

> *"...a recent study of home heating dynamics indicates the current faith in insulation may be based on erroneous assumptions, and that home owners pouring money into the burgeoning insulation industry won't see the savings they have been promised. ... The key fact is this: Insulation is a good material and six inches can do the job nearly as well as 16 inches. ...*
>
> *If you are building a house, three inches of wall insulation will be helpful. But if you are considering insulating the walls of an existing home, remember that the total heat loss through an uninsulated wall is only about 5 per cent. The addition of insulation will only trim this figure by 1 or 2 per cent, meaning the ... savings on a $400.00 heat bill would be less than $10.00. It is highly unlikely you would ever regain the cost of such a project. ...*
>
> *The insulation in the homes varied from one to 10 inches in thickness. But the more heavily insulated homes consumed as much energy as the lightly insulated ones. There was absolutely no trend to substantiate measurable energy savings by increasing ceiling insulation beyond a relatively small thickness..."*

The subject of infiltration, Dr. McGrew calls *"rivers of air"* is the most interesting part of the study for the radiant heating program and strengthens the importance and value of the process.

> *"The study found that in a house with three inches of attic insulation, about 66 percent of the heat is lost through infiltration, a process not affected by insulation. About 17 per cent of the heat is lost through windows, about 11 per cent through the ceiling, and about 6 per cent through uninsulated walls. ...*
>
> *The researchers used a precision hot-wire anemometer to measure the flow of air near the furnace, hot water heaters, and kitchen and bath room vents. ...*
>
> *As the furnace is burning, room air is drawn into it far in excess of what is needed for combustion. The air is heated and sent gushing up the chimney. As air near the furnace is sucked in, air from elsewhere in the room flows to replace it. The researchers were able to measure a river of air pouring into the furnace at the rate of several hundred cubic feet a minute. ...*
>
> *Because a house can't exist as a vacuum, every cubic inch of air that leaves the house must be replaced by new air coming in. So as warm house air is exhausted from one set of flues and vents, cold air from the outside is flowing in through the other. A wind can accelerate greatly this expensive exchange."*

Dr. McGrew utilized a variety of homestyles in the Denver area using, ... *" sophisticated monitoring equipment to find out precisely what happens to energy consumption within the home."* I searched for recent insulation research that either disputed or debated these conclusions, but have not found other articles as carefully monitored or more inclusive.

Now, looking further into the important issue to the enhancement of the radiant heating process, **RADIANT BARRIERS** must include good reflective surfaces to allow owners to have the best of both worlds-better comfort and better energy efficiency in heating and cooling seasons! Combined with a plastic wrap for reducing structural infiltration, using installation of *foil-backed* fiberglass and/ or drywall, will produce the *perfect radiant* "envelope" results. Reflective inducted products maintain a high radiant temperature quality and builds a radiant reflective barrier.Using more fiberglass insulation, contrary to manufacturers advertisements, adds cost without adding comfort or a reduction of energy or fuel consumption.

Keeping heat either in or out of a structure can be a challenge. The use of radiant barriers will allow us to achieve our goals of better comfort and better energy efficiency, and be cost-effective.

In an article Mr. Philip Fairley, research scientist at the Florida Solar Energy Center, references are made to the value of radiant barriers, primarily from a cooling stand point. Implications of his remarks and my experiences over the years with reflective surfaces and their relationship to room heat loss, leads into some thoughts that are meaningful to system planning for your next project.

> *"We largely ignore radiation... But research points to some exciting potential for reducing heat gain* [or heat loss] *through controlling radiation transfer in the walls and ceilings. Though it is difficult to understand and even harder to model accurately with computers, we can still use radiation control if we grasp some basics about how radiant energy enters* [or leaves] *buildings. ... while conduction and convection need a medium to pass through, radiation passes through a void. Radiation needs only two regions of different temperatures that 'see' each other.*
>
> *Radiant barriers in buildings are materials placed such that they restrict the amount of far-infrared radiation that passes across the attic and wall cavities. Two things are necessary: 1) the barrier material must have a low emissivity, and 2) there must be an air space* [for cooling] *to the radiant barrier. Low-emissivity materials are highly reflective to far-infrared radiation, making them the best candidates for radiant barriers. Aluminum foil is an excellent radiant barrier. Because it has a low emissivity, it reflects 95 percent of the longwave energy that strikes it. ... We know, for example, that white paint reflects far more visible radiation than black. ...*
>
> *A radiant barrier's resistance to heat flow is hard to understand because it differs from our usual frame of references: R-value. ... R-value measures resistance to condition, rather than convection or radiation. This is why aluminum foil, a good conductor with negligible R-value, does not seem a likely canditate to improve a building's thermal performance."*

Summarizing **1)** the radiant heating process heats without moving air, eliminating a vast amount of energy wastes from outdoor air infiltration. Infiltration is markedly increased by furnaces blowers, sucking air into the structure through doors, windows, fireplaces, and exhaust fans. **2)** Air type heating systems stratify or "pile-up" hot air on the ceiling that eventually drifts in layers down into the room until it is comfortable for the occupants. The higher the ceiling heigth, the longer this "layering" proces will take.Stratification increases structural heat loss, the infiltration process, and causes anoying drafts. **3)** The insulation process is found to be the reverse of what is normally advertised. ***REFLECTIVENESS*** definitely becomes *the* important issue for the radiant heating process. Insulation "R" values are much less important. **E**ffectively taking advantage of these features for the radiant heat process - that does not stratify warmed air- maintains even floor to ceiling temperature, provides a "toasty" comfort quality, eliminates drafts and cold spots, reduces indoor infiltration, structural heat loss, **and** energy and fuel cost.

Radiant Systems Enterprises

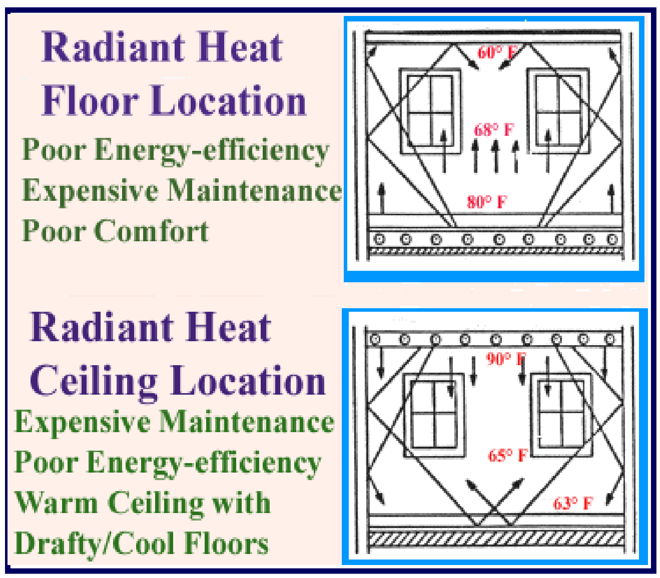
To *EMPHASIZE* a point - from our 25 year experience

Panel selection and placement is the most important single factor for optimum energy efficiency and comfort.

The importance of panel location is repeatedly emphasized in engineering literature and has been tested for comfort performance and energy efficiency.

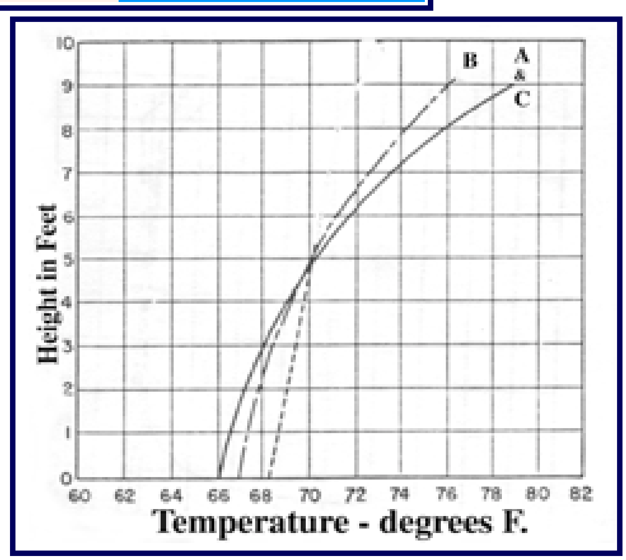
We've read before in ASHRAE - these heat unit placement locations product poor results. Let's look into the reasoning behind these field tested results:

1) poor heating quality, - **no** radiant barrier between cold surfaces and people to prevent radiant losses from the body, **2)** very little energy conservation, - thermal lag too long,and heat is wasted by conduction - either up or down), **3)** difficult to divide into modulars - for heating only the "lived in areas". **No** possibility for controlling energy usage, and **4)** Costly maintainence or replacement

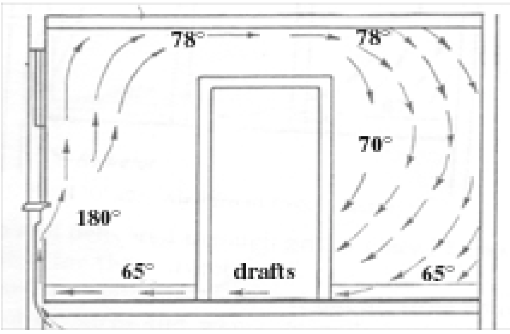


NOW WHY?

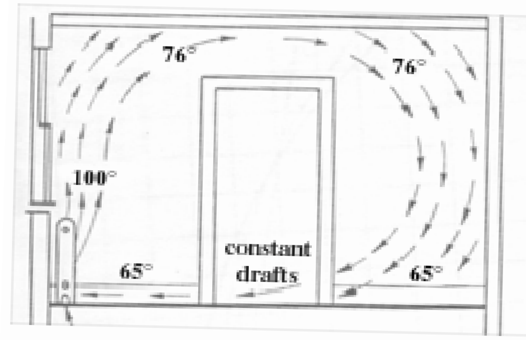
In ceiling radiant applications (C),or hot water (A), or standard baseboard (B) installations, an excessive amount of heat is wasted through the ceiling. Forced air heating has the same effect. The ceiling becomes an enormous heat loss. Contractors try to cover up this problem by recommending the use of ridiculous amounts of "R" value insulation . No energy is saved and the added cost for insulation will never pay back to the owner in any reduced heating cost savings. Ceiling radiant is the most wasteful. Using even adaquate insulation is impossible. Heat is constantly wasted by conduction into attics or other structural spaces.



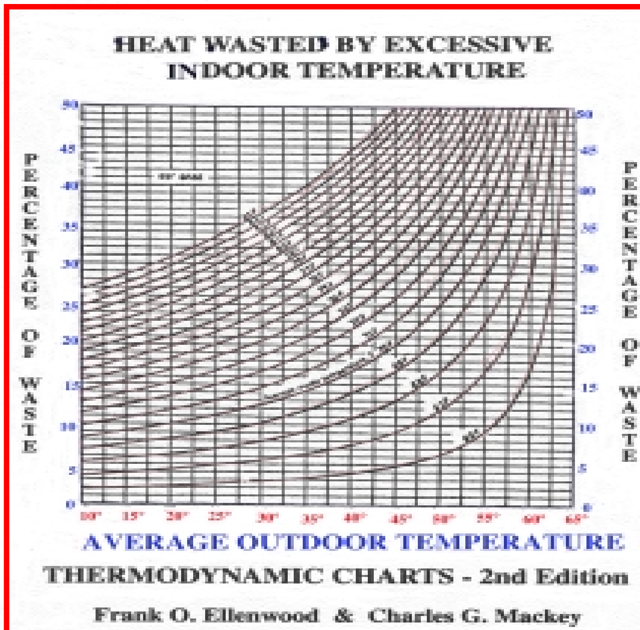
A ceiling radiant or all convection heating sources, increases the floor to ceiling temperature variation problem. AGAIN, poor, drafty comfort and lots of wasted energy!



Convection baseboards, forced air and hot water heating causes big variations in temperature between t ceiling and floor. This increases heat wasted by conduction/ transfer and also results in poor comfort - drafty floors and many uncomfortable cold spots.



Now to emphasise why a poor radiant source location wastes lots of energy, and ought to end further arguments - to the right, is a heat waste table. The table illustrates that <u>most heat is wasted</u> <u>during</u> the <u>mild days of the heating season</u>, **or** during most of the year. Conduction losses with either heat source placement through floor or ceilings is also a big energy waste concern. The excessive thermal lag (time between energizing the heating system and actually feeling the comfort in the room) is excessive - at least 30 to 40 minutes or more, componds the issue. In mild heating days, when you need heat you must wait for the warm-up and when it warms up outside, you become too warm inside, and must wait for it to cool down. This wastes a tremendous amount of energy.



Floor radiant makes individual room (modular) temperature setting almost impossible and very costly! When installed as modular, adjustments need seasonal changing and balancing is difficult! Owners that I have known usually forget the balancing and heat whole floors wasting energy in unused rooms. Conduction waste through floors is a waste situation impossible to resolve wasting heat to unneeded areas within the structure.

The **worst** feature of the floor or ceiling radiant heat location -there is **no radiant barrier** between cold surfaces and people and comfort is sacrificed! Every heating situation using convection heating from air type systems, baseboard or hot water convection units especially, will also fail to keep people comfortable because they fail to produce a barrier between cold surfaces and people. The floor or ceiling is warm, but people feel cool. People lose heat from their bodies to cold walls and windows. People are comfortable only when a radiant energy barrier protects them from cold surfaces is in place, preventing radiant losses from their bodies.

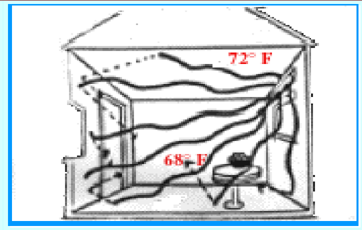
Enough about the wrong placements -

What about the right solutions?

These placement locations are perfect for meeting every requirement for optimum comfort and energy efficiency. They allow direct and indirect radiation so that sufficient “shine” is emitted in quantities that produce the best comfort and energy efficiency. Each heating station is individually controlled with a thermostat, so the owner is in position to control energy consumption. The quick response of the radiant panels permits room thermostats to be utilized like “off/on” light switches - whether or not the living area is being used. Energy is effectively conserved -**1st,** by the individual room thermostat control - **2nd,** lowering ambient room temperatures, 3-5°, **3rd,** radiant comfort eliminates the temperature stratification between floor and ceiling, **4th.** entire structure is automatically controlled by an outdoor sensing control process that responds to changing structural heat losses as temperatures increase or decrease. NO WASTES, NO DRAFTS, NO WASTED ENERGY! These products are designed to provide excellent comfort andenergy efficiency for years of maintenance free operation!

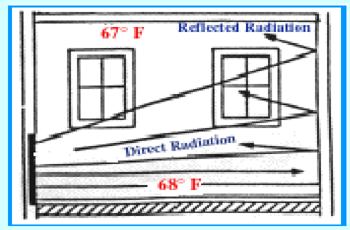
Radiant Cove Heater Location

Low Maintenance
Energy-efficient
Even Comfort



Radiant Wall Heater Location

Low Maintenance
Energy-efficient
Even Comfort



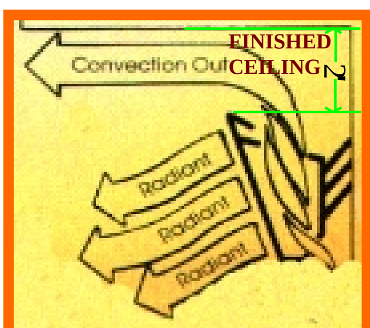
PROPER LOCATION CONSTRUCTS A SOLID RADIANT BARRIER between cold surfaces and room occupants - thus maintaining BETTER COMFORT and LESS AMBIENT TEMPERATURE which LOWERS FUEL COSTS.

Tie together the correct radiant source placement and heater location for comfort and efficiency, and balance this with the available radiant heating products. ***BUT,***
Can any one product perform effectively for every type of application?

These panel configurations will perform consistently in all types of installations and provide excellent comfort, energy efficiency, and are easily controlled with our energy management controls

Our successful project applications include dozens of motels, apartments, nursing homes, assisted living residences, swimming pools, gymnasiums, hotels, service garages, maintenance buildings, camps, schools, paint bays and many dozens of private residences

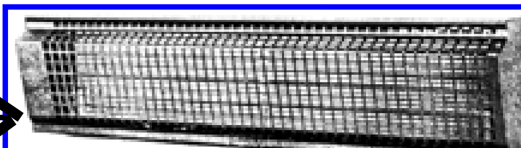
The radiant cove heater is a perfect unit for use in rooms with limited ceiling height (10' or less) and where floor surfaces are needed for furniture or fixture placement. This unit heater’s effectiveness is reduced by the air movement required yo comply with local ommercial building codes, Installation calculations ought to compensate for this limitation in addition to the BTU loss.The cove heaters is an excellent solution for many applications. The cost is reasonably low and they are virtually maintenance fee - warranted for10 years.



COVE HEATER

#945 RADIANT WALL

A PERFECT RADIANT BASEBOARD



#545 RADIANT BASEBOARD

These wall panels and baseboards are excellent for all types of radiant installations, from living rooms to the largest gymnasiums and schools. Perfect for high ceiling homes. They are very durable and have been used in swimming pool applications for over 20 years without signs of deterioration. These wall panels will keep floors warm, even when installed 15'-20' above the floor. They cost more than the cove units, but for the demanding "hard to heat" projects, these are the best units for comfort and efficiency.

The value of ***Radiant Systems Enterprises*** *for the end user, is to accurately predict annualized heating operational costs.* **Detailing this –**

HEAT COST

TO OPERATE & TO PURCHASE

Accurate predictions of annualized utility costs for various heating fuels is possible using calculations provided in ASHRAE engineering handbooks. Structures have their own individual characteristics and energy cost can vary greatly. This might include family life style in a home or the usage quantity in commercial building. HOWEVER, with our radiant panel heating system and the energy management control product developed by our company, our heating cost predictions have exceeded expectations, throughout the 25 + years we have been in the business of radiant system design.

Printed in the "Federal Register", as reported by the Department of Energy, fuel escalation predictions. The next few years seem to place an interesting light on the selection of an energy source appropriate for the owner to use.

Residential and Commercial fuel escalation predictions

	1995-1999	**2000-2010**
Electricity:	**.32-35%**	**.10-.13%**
Natural Gas:	**2.27-2.64%**	**1.90-2.01%**
Distilate Oil:	**3.28-3.40%**	**2.19-2.25%**
Liquid Gas:	**1.73-4.02%**	**6.02-6.40%**

Notes: Complete report available: Government Relations Office, 2020 14th Street, Arlington, VA. Every recent natural gas cost increases has exceeded all predictions

How is annualized operating cost calculated?

Using the following two formulas from the ASHRAE, Fundamentals Handbook, chapter 28, from the section entitled *"Energy Estimating Method"*, estimates of annualized energy costs for various heating fuels can be calculated with a reasonable degree of accuracy.

ANNUALIZED CALCULATING

1

$$\frac{\text{BTU LOSS} \times \text{DD} \times 24}{\text{TD} \times \text{E} \times \text{R}} \ (.62) = \text{Consumption/year} \times \text{fuel cost per unit}$$

DD = area degree days **E** = fuel experience factor **TD** = area temperature difference
R = BTU's of heat produced from a unit of fuel.

Using the B.T.U. loss in each example of 100,000 BTU/YR., it is possible to obtain estimates for the amount of fuel needed for a typical heating season in a 5,700 degree day area of the US. Multiplying the unit number by the current cost for the fuel = an annualized cost estimate.

OIL

$$\frac{100{,}000 \times 5700 \times 24}{70 \times 60 \times 144{,}000} \ (.62) = 1{,}410 \text{ gal./yr. @ \$1.05} = \$1{,}485.00$$

It is impossible to obtain **(E)** l44,000 B.T.U.'s from a gallon of oil in actual field operation. **IF** 100,000 B.T.U.'s were possible, - the usage would be 2,020 gal. per yr. @ $l.05 = $2,125.00. An accurate expectation might be 60,000 B.T.U.'s per gallon, using 3,370 gal./yr. @ $l.05 which would give us an expense that relates to field tested cost of $3,540.00 per heating season. Water, rust, and dirt contaminates cause a marked decrease in oil fuel burning inefficiecy.

NATURAL GAS

$$\frac{100{,}000 \times 5700 \times 24}{70 \times 55 \times 100{,}000} \ (.62) = 2{,}210 \text{ ccf's/yr. @ \$ .67} = \$1{,}480.00$$

Two variables need to be considered when evaluating natural gas consumption: the experience factor (**E**) of the heating unit, and the usable B.T.U.'s per therm. An **E** of .45 = 2,700 t/yr. @ $.67 = $1,810.00 per yr.; **E** of .8 = 1,515 t/yr. @ $.67 = $1,010.00 per yr.; **E** of .9 = 1,350 t/yr. @ $.67 = $910.00 per yr. **BUT,** If the gas system is firing a hot water boiler that passes through many feet of pipe before being used for room heating, **or** should a forced air type system pass the warm air through long ducts, the usable B.T.U.'s of heating value in either case would be greatly reduced. A reduction factor: of 20% = 2,755 therms/yr. @ $.67 = $1,850.00 per yr.; of 30% = 5,800 therms/ yr.@ $.67 = $3,400.00 per yr.,etc.Unclean burners and stack losses reduce the efficiency of natural gas burning. Pulse furnaces enhance burning efficiency, but at the expense of higher maintenance.

ELECTRICITY

$$\frac{100{,}000 \times 5700 \times 24}{70 \times 1.0 \times 3414} \ (.62) = 35{,}490 \text{ KWH/yr. @ \$.04} = \$1{,}420.00$$

What is the effect of changing our **(E)** 1.0 multiplier in the above equation to 1.3, 1.35, or 1.4?
1.3 = 27,300 KWH = $1,090.00 /**1.35** = 26,290 KWH = $1,050.00. **THESE ARE REAL COSTS!**

BUT,
Can we truly justify a higher experience factor for our program? Let's see -

An experience factor of 1.0 is normally used for all types of electric heating, such as baseboard heaters and other types of resistance heaters. Electric furnaces pass air through ducts, greatly reducing fuel efficiency. The radiant heating process increases the effectiveness of using electricity and minimizes wastes by use of our energy management control system. **A recent article** in the July 1996 **ASHRAE JOURNAL,** provides evidence that radiant wall panels used 33% less electricity than heat pumps and 52% less electricity than baseboards. Thus, justification for using a higher factor in calculating consumption for radiant panels w/ controls can be shown in the formula given below.

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2 Overheating of the walls and floors from excessive indoor air temperature, increase structural heat loss through transmission losses. ASHRAE provides the following equation: **Q = U A (to - ti)** where: **Q** = heat loss (BTU/HR **U** = heat transfer factor **A** = area of surface **to** = outside air temperature **ti** = inside air temperature. ***So*** for a given outside air temperature,this formula illustrates how we can waste energy with a high room temperature. **Therefore**, it is obvious that a lower room thermostat setting while still providing comfort, means less energy will be wasted.

Here is the formula relating to that statement: $To = Ta + \frac{H_r}{h_o}$

where: Ta = ambient air temperature $\frac{Hr}{ho}$ = radiant component

Recommended values for **To** and **ho** are tabulated in the Ashrae Systems Handbook. For example - a person sitting down with medium clothing, little air movement - *ASHRAE* - operative temperature. **To** = 75 degrees and **ho** = 1.3. *Therefore*, in order to lower the room ambient temperature while remaining comfortable AND conserving energy consumption, we **MUST** increase the radiant component (**Hr**)

Listing these conclusions, **1)** an effective use of electricity by our energy management product, **2)** reduces heat loss to the structure by preventing overheating of outside walls, ceilings, and windows, **3)** while maintaining comfort with a lower ambient air temperature, and **4)** no drafts, cold spots, or moving air currents from blowers that will cool the body we have the optimum in comfort and energy efficiency. **THAT'S IT!**

If you are a designer, specifying engineer, or project owner, or building a new home we would be pleased to assist you wherever possible in the design, bidding, construction, and punch-out phases of your project to develop an outstanding climate control program for you or your client.

CONTACT US: **CALL** - 877-885-1189 (Toll-free)
E-MAIL - RADSYSJED@SPRINTMAIL.COM
WEB SITE - RADIANTHEATSYSTEMS.COM
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Jim Dawson

NOW - Check out or print out the BTU loss to fuel consumption/cost analysis on the table on the next page. (An engineering firm did thiese calculations)

Use ACROBAT tool to turn and view or to print heat cost calculation chart.

Annual heating operating costs - Estimated comparisons

(6,000 D.D. / 0° - 70° T.D. / 70° ambient room temperature)

HEAT LOSS IN	OIL FURNACE		GAS FURNACE		ELEC. FURNACE OR BASEBOARD		RADIANT HEAT		RADIANT HEAT with ENERGY CONTROL SYSTEM	
BTU/HR.	GAL.YR.	@.95/GAL.	CCF/YR.	@.0058/CCF.	KWH/YR.	@.05/KWH	KWH/YR.	@.05/KWH	KWH/YR.	@.05/KWH
10,000	232	$ 220.40	28,481	$ 165.20	4,270	$ 213.50	3,571	$ 178.50	2,500	$ 125.00
20,000	464	$ 440.80	56,962	$ 330.40	8,558	$ 427.90	7,142	$ 357.10	5,000	$ 250.00
30,000	697	$ 662.20	85,443	$ 495.70	12,838	$ 654.70	10,714	$ 546.40	7,500	$ 382.50
40,000	929	$ 882.60	113,924	$ 660.80	17,111	$ 872.70	14,285	$ 728.50	9,999	$ 509.90
50,000	1,162	$ 1,103.90	142,450	$ 826.30	21,397	$1,091.20	17,857	$ 910.70	12,500	$ 637.50
60,000	1,395	$1,325.30	170,886	$ 991.20	25,676	$1,309.50	21,428	$1,092.80	15,000	$ 765.00
70,000	1,627	$1,545.70	199,368	$1,156.40	29,956	$1,527.80	25,000	$1,275.00	17,500	$ 892.50
80,000	1,859	$1,766.10	227,849	$1,321.60	34,235	$1,745.00	28,571	$1,457.10	20,000	$1,020.00
90,000	2,092	$1,987.40	256,330	$1,486.80	38,514	$1,964.20	32,142	$1,964.20	22,500	$1,147.50
100,000	2,324	$2,207.80	284,811	$1,651.90	42,794	$2,182.50	35,714	$1,821.40	25,000	$1,275.00
110,000	2,557	$2,429.20	313,292	$1,817.10	47.073	$2,400.00	39,285	$2,000.00	27,500	$1,400.00
120,000	2,789	$2,649.60	341,773	$1,982.30	51,353	$2,619.00	42,857	$2,185.70	30,000	$1,530.00
130,000	3,022	$2,870.90	370,254	$2,147.50	55,632	$2,837.20	46,428	$2,367.00	32,500	$1,657.50
140,000	3,254	$3,091.30	398,736	$2,312.70	59,912	$3,055.50	50,000	$2,367.80	35,000	$1,785.00
150,000	3,487	$3,312.70	427,217	$2,477.90	64,191	$3,273.80	53,571	$2,732.10	37,500	$1,912.50
160,000	3,719	$3,533.10	455,698	$2,585.10	68,470	$3,492.00	57,142	$2,914.20	40,000	$2,040.00
170,000	3,952	$3,754.40	484,179	$2,808.30	72,750	$3,710.30	60,714	$3,096.40	42,500	$2,167.50
180,000	4,184	$3,924.80	512,660	$2,973.50	77,029	$3,928.50	64,285	$3,278.50	45,000	$2,295.00
190,000	4,417	$4,196.20	541,141	$3,138.70	81,309	$4,146.80	67,857	$3,460.70	47,500	$2,422.50
200,000	4,650	$4,417.50	569,625	$3,303.90	85,590	$4,365.10	71,430	$3,642.90	50,000	$2,550.00

Notes: 1) T.D. = Indoor temperature - 70°, outdoor temperature - 0°
2) D.D.= 6,000 as measured by local weather reporting agency.
3) Insulation values are to be considered equal for all fuels.
4) Oil, gas, and electric consumption calculated in ASHRAE Handbook, 1996, page 43.8
5) oil efficiency = 70% - gas efficiency = 80%
6) Radiant heat calculated with N.E.M.A. experience factor of 240 - with energy control system 70% of 240 experience factor.
7) These are *estimated calculations* and not to be otherwise considered.

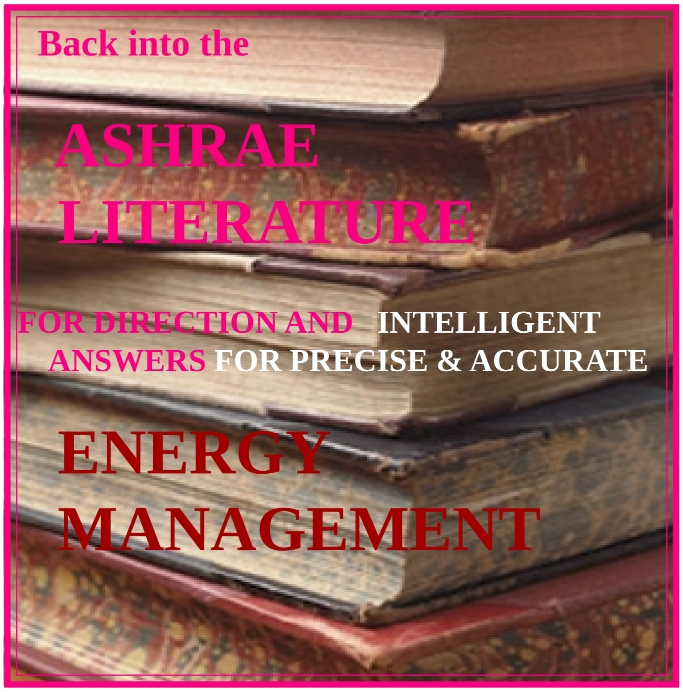
RADIANT HEATING WITH *OR* WITHOUT CONTROL COMFORT IS POSSIBLE WITH AN AMBIENT OF 65°

BTU/HR.	KWH/YR.	@.05/KWH	KWH/YR.	@.05/KWH
30,000	**9,048**	**$ 461.40**	**6,964**	**$ 355.40**
50,000	**16,581**	**$ 845.60**	**11,607**	**$ 590.00**
60,000	**19,897**	**$1,014.70**	**13,928**	**$ 710.30**
80,000	**26,530**	**$1,353.00**	**18,571**	**$ 947.00**
100,000	**33,163**	**$1,691.30**	**23,214**	**$1.180.00**
130.000	**43,122**	**$2,200.00**	**30,178**	**$1,540.00**
150,000	**49,744**	**$2,471.10**	**34,821**	**$1,729.50**
200,000	**66,326**	**$3,382.50**	**46,428**	**$2,367.50**

ASHARE engineering data emphasizes that comfort is optimum when a balance is established between ambient air temperature and the radiant temperature-a higher radiant factor, the lower the ambient temperature without sacrificing comfort quality. Maximum comfort level with lower air temperature means lower fuel costs, *therefore* comfort within the radiant environment meets comfort requirements while being energy efficient!

With all of the discussion in the previous section, What is your answer for Energy Management Controls?

RADIANT SYSTEMS



ENTERPRISES

INTRODUCES OUR

ENERGY MANAGEMENT CONTROL SYSTEM

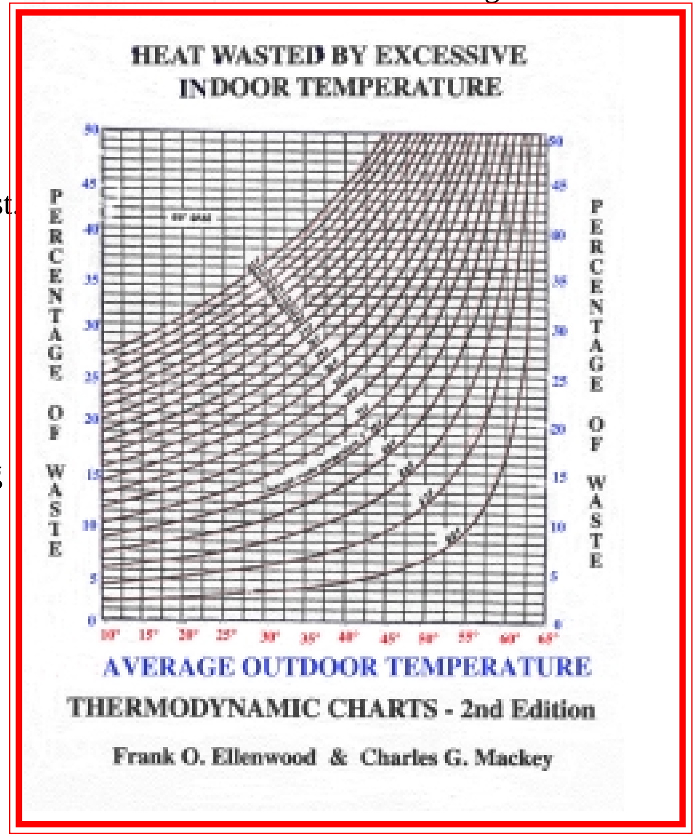
ASHRAE literature lists two requirements for reducing energy wastes for successful energy management products: **1)** wastes from **over heating**, especially in the mild heating seasons, and **2)** wastes from **over sized heating equipment.** They also included other points they considered important.

In 1980, Radiant Systems found available energy management products left much to be desired in being cost-effective, user friendly, or reliable. Most performance reports were less than expectations and durability to strains of commercial users, without excessive repairing, were definitely problems that needed resolution. Model changes and upgrades were frequent. Owners were left with equipment that required specialized maintenance. Long waits for repair personnel, parts, and useful operational manuals were other complaints heard from buyers. Add to this, initial costs for product and the professional installation was very expensive!

Our goals were: **1)** to reduce energy wastes from indoor **overheating**, **2)** reduce wastes from **over sized equipment**, **3)** be **user-friendly**, **4)** **simple** to install and maintain, **5)** be **cost effective** to purchase and maintain and **6)** very energy efficient!

Engineers felt the task of developing an energy management product that would respond to the specific and unique characteristics of the radiant heating process, would be too costly for a small business. One engineer that had designed the radiant heating process into many commercial projects and extremely knowledgeable in the radiant heating process developed a working model that fulfilled the requirements. Field testing produced improvements to the products performance and reliability, necessary to the commercial or residential radiant user. Another engineer friend, an M.I.T. graduate, combined years of field control expertise with our field testing results, developed a product that met the requirements in ASHRAE completely. Performance records have been consistently better than anticipated, maintenance has been virtually eliminated in applications from Florida to the coldest parts of Minnesota and Colorado.

SOLUTION #1 ***EXCESSIVE INDOOR TEMPERATURE*** is a big causes of energy wastes. Careless use of room thermostats, or trying to balance a home or an entire floor in a building with one thermostat, results in huge energy wasting and inadaquately balanced comfort for the inhabitants. NOT GOOD!

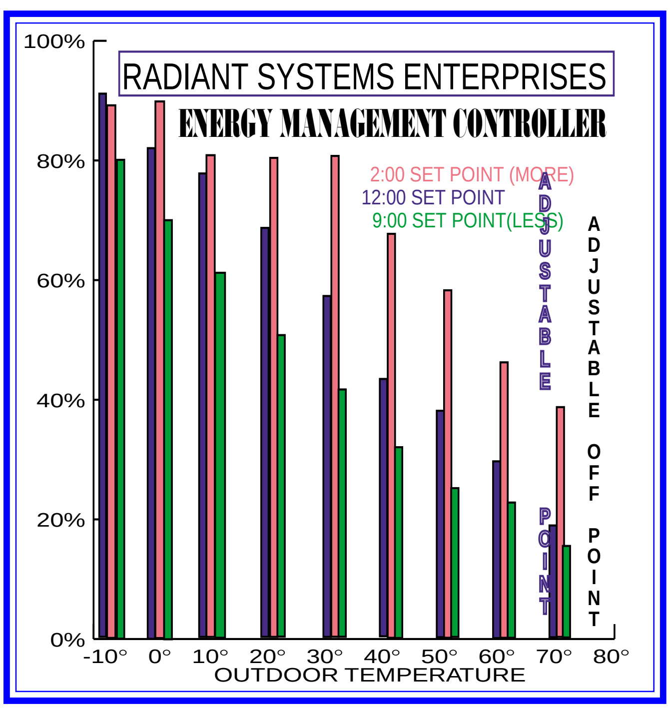


The waste table illustrates waste possibilities. Wastes are minimal when the outdoor temperatures are lowest. Energy wasting increases as the outdoor temperature increases, in mild heating days. The most obvious conclusion in this research study is that increasing indoor temperatures to accomodate individuals with special needs, i.e., nursing home residents, elderly unable to walk, hospital patients, or people that like a warmer indoor conditions, increases energy wasting tremendously! Economically undesirable.

The **radiant heating process** reduces the heat waste problem by maintaining comfort with an ambient 3° to 5° lower than air type heating systems. This comfort process eliminates drafts, cold spots, and irritating air noises that are common with other systems.

The **RADIANT ENERGY MANAGEMENT CONTROL SYSTEM** attacks the entire issue by reducing energy consumption proportionally as the outdoor temperature increases and avoids the energy wastes shown on the table above,and most present during the mild heating seasons of the year. In most of the US. this is most of time during the spring, fall and winter heating seasons.

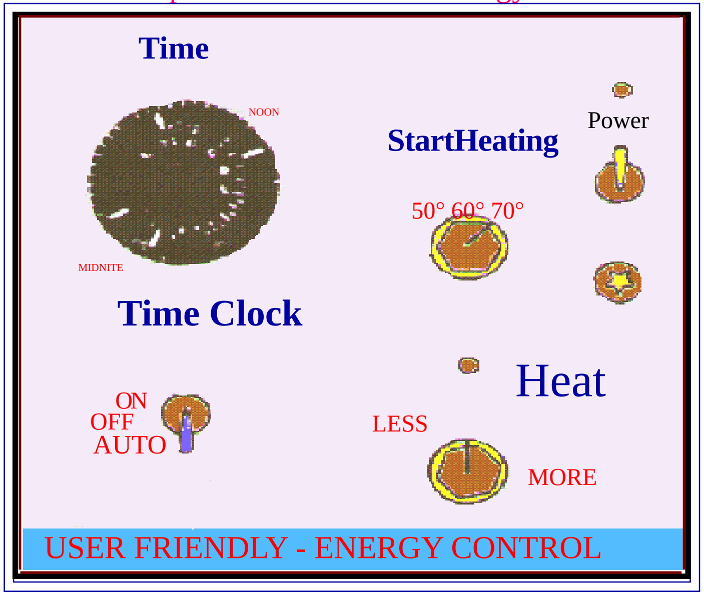
SOLUTION #2 Eliminating the energy wastes from ***OVERSIZED HEATING EQUIPMENT*** is the next step ASHRAE requires for energy management control products. The ASHRAE charts point out that a oversizing heating equipment by 35% wastes 55% in energy - over size by 50% wastes 75% - oversize by 100% means 225% in wasted energy. The graph below, shows the saving possibilities with our management controller.



The radiant heating process is substantially enhanced by the reflective characteristics of interior design. Reflective insulation, foil wall coverings, and light colored paints improve the re-radiation process and therefore the user can reduce the amount of energy consumption. By taking advantage of the reflective values and adjusting the dials to accomodate the characteristics of the structure, energy is conserved. A real Radiant Advantage, and this product allows the user to do this!

The graph shows an expected energy useage with the "More" or "Less" dial set in the “12:00” position, a less proportional amount in “9:00” position, etc. Adjusting the heat dial to the desired comfort point, an exact energy usage for structural variations and user needs is possible. With a short 72 second cycle, a proportional amount of "on" time is calculated to the changing outdoor conditions and satisfy the heat loss. No temperature variation or reduction of comfort. Heater density and the short cycle duration are key factors to the our successful economical operation and good comfort.

The front panel of the Radiant Energy Controller.



SOLUTION #3 A very important feature for an energy management product is it be understandable and ***USER FRIENDLY.*** I have been asked to help with expensive products for managers and users that were either too difficult to accurately calibrate in the field,with incomplete, poorly written manuals and were not useable. Manufacturers were trying to attack too many aspects of the energy saving task, resulting in very high first cost and complicated user involvement. Impractical for managers, users and/or owners.

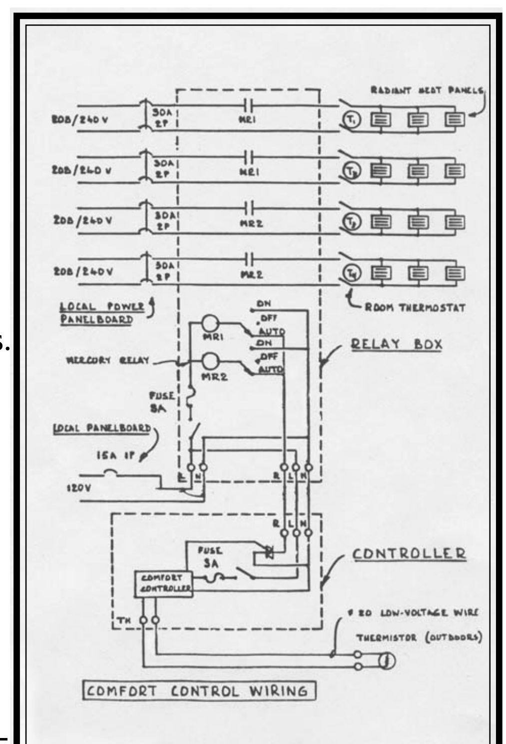
The dials on the face plate of our energy control, management product are simple to use. Once set they never need readjustment! The ONLY goal is to reduce electrical consumption and demand costs.

In field testing our performance records consumption reductions between 20%-30% and demand reductions of 25% to 35%. Remember, interior reflectiveness greatly affects energy consumption.

The **HEAT QUANTITY** adjustment("more" or "less"), allows for exact cycle balance to accomodate for interior reflectiveness and the comfort point best suited to the user. The **START HEAT** adjustment is pre-set to 68°, which is a perfect temperature for starting and stopping the heating process. This avoids heating wastes when solar or influences are affecting interior temperature. The **TIME CLOCK** has become an option. It does save on heating costs by setting back heat "ON " time during night hours or when at work. This caused the most questioning by users and the value seemed to be less than the savings in energy. So owners usually did not use the set-back, thus it became an option that not many purchassed.

IMPORTANTLY, after initial calibration, our control product is **completely automatic**, needing no user involvement! The entire system can be turned " off " in the no-heating months with the power switch.

SOLUTION #4 The **installation process** has been simplified. Owners can install units themselves. The process uses 2 boxes - **CONTROLLER BOX** is located wherever the owner desires, connected with 3 - #14 wires to a **POWER/RELAY BOX** that breaks one leg of each heating circuit. In complex structures like motels, schools, offices, etc. power boxes are 3-wire linked to accommodate the required circuits for the building or home. An outdoor thermister sends data to the processor for dictating accurate electrical cycling proportions to meet the heating needs. These simplified installation tasks mean less installation cost.



The design process also includes simplified maintenance. The "off"-"on"-"auto" switches in the power box permit the system to operate should a **Controller Box** failure occur. "Auto" is the normal position when the Controller unit. is operational. For a repair, the "ON" position allows heat to pass to the area therm-ostats. Failure has been extremely infrequent and repair turn around is within a few days. All parts are UL. approved.

Economical energy usage, installation costs, and virtually main-tenance free-this solidly fulfills ASHRAE's requirements for energy management control products!

SOLUTION #5 & #6 Another complaint that designers and owners voiced was the fact that energy management products had a high initial first cost. Payback for equipment purchase was too long. Again as manufacturers added features to the product, costs escalated, but many of these features saved only small amounts of energy. We felt that if our management product could be designed with emphasis placed on reducing the biggest energy wasting problems, then product cost could be maintained at a level acceptable to a responsible life-cycle analysis. We have stayed within this framework and our product for reducing substantial amounts of electrical demand and consumption costs has been developed at a cost that is remarkably below any other such product that is available.

NOW - how does all of this really work in the field, to save on energy consumption? Let's look at some illustrations of actual projects.

#1 Our first set of examples, includes two apartment buildings without the controller product designed to meet H.U.D. specifications for energy usage and for elderly occupants. They illustrate the value of the radiant process to conserve electrical energy costs.
A A renovated hotel where the initial cost for the radiant heating and unit air conditioners was engineeringly calculated $300.00 a unit below the through-the-wall process and over $1,000.00 a unit below a four-pipe water system. Operational costs in comparison to other similar buildings (4) constructed with similar construction specifications using electric baseboard heaters, were 28%-35% more energy efficient using radiant heating.
B A twelve story, 100 unit building using the latest in new construction materials. The per square footage heating cost was calculated to be about 15-18 cents, depending on unit occupant.. These calculations and reports are available for your review upon request.

#2 A nursing home project that was built in 1982. The radiant heating process was chosen to include our energy management product. Not detailing the economical installation program or the low (under $800.00) maintenance for controls or heat panels, the operational costs are most impressive. Using 2-3 years of electrical reports from the utility company, a figure of approximately 50 cents a square foot for total energy usage was calculated, with 36.5 cents for heating and 14 cents for cooling. Since elderly guests do not like much air conditioning, the heating costs were many times lower than other heating systems used in nursing homes. Is it any wonder the owner's first request when building a new facility many times larger than the above, some 18 years later, was for radiant heating with our management controls? These owners were impressed with the draft-free, even, non-noise and air movement heating process. Investment visitors to the facility were impressed with the custodian stepped up to turn down the temperature in one of the mult-purpose rooms saying, "above 70° is too warm with radiant heat - the investors used our products in their next four nursing homes. This report is available in detail.

#3 I have collected energy reports frommotel companies that have used our heating and control products for many years in dozens of locations, some within the same city constructed earlier using through-the-wall units. After several hundred installations. energy consumption reports showed demand reductions ranged from 25%-32% and electrical consumption reductions in the 25%-28%. Electrical wiring, power boxes, transformer size reductions saved initial costs and electric usage placed the properties in favorable rate classifications. Summarized reports from some of these projects are avaliable.

#4 I have a substantial number of energy reports from private residences. Some using the energy management controls and some without. Energy reductions are also most impressive, The heat cost comparison to natural gas costs is almost amazing. Square footage heating costs for gas are between 75-95 cents - radiant between 16-28 cents - these figures, developed by an engineering firm for their use in specifying the radiant heating. Some engineers chose to ignore the radiant process entirely.It requires changing thought.

BUT - I emphasize that owners (nursing home, school, assisted living, homes, motels, apartments) most often mention the comfort, evenness, draft-free, and quiet features of the radiant process. Energy conservation and low maintenance seem almost unimportant in comparison to these outstanding features noted by their guests and occupants.

Let's review the impressive features of the energy management process

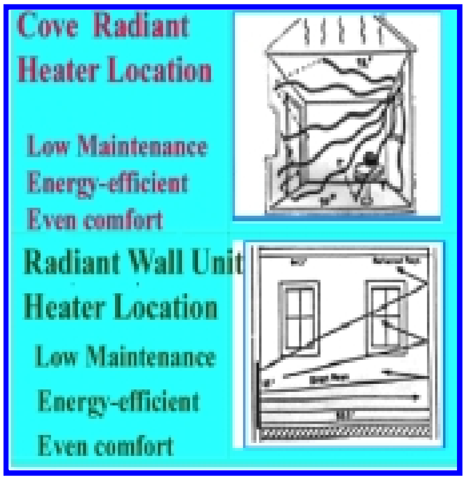
#1 Energy wastes from **excessive indoor temperatures** are disastrous to energy conservation. The control process removes these wastes by reducing indoor temperatures to harmonize with the already lower temperature ambient of the radiant heating process.

#2 Energy wastes from **oversized equipment** are eliminated by sizing the unit output to meet the heat loss of the structure based upon the varying outdoor temperature demands. The heat cycling process is totally automated to utilize the density of the heat panels. The short cycling period eliminates air mavement noises and maintains optimumcomfort throughout the management process.

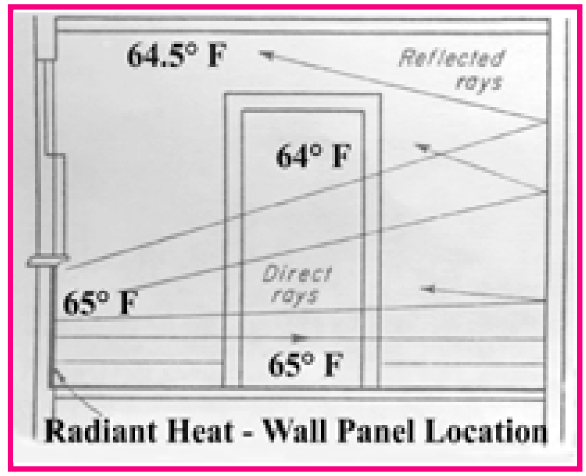
#3, #4 & #5 Individual involvement in the operational aspect of our energy management product has been totally automated to be **user friendly**! Instructions for adjustments are simple and maintenance problems are easily targetedand resolved. **Installation** has been simplified to keep installation and maintenance costs low. **Initial costs** are a fraction, thousands of dollars less than products saving much less energy.
#6 **Performance** outstanding results!

A quick review –

The effect of careful planning with radiant panel location, has a decidedly dramatic impact on people comfort and energy efficiency!



Note even temperature between floor and the ceiling, also means even humidity between floor and ceiling. *Humidity* is an important factor in the comfort equation. Cooler ceilings reduce ceiling heat losses and negates the need for excessive ceiling insulation and related costs.



ALSO – there is in place, the all important ***Radiant Barrier !***

The absolute essential element for comfort and fuel efficiency

The *barrier of radiant energy* (warmth) stands between the people within the room environment and the cold surfaces of outside walls and windows, preventing heat loss from the body that causes discomfort and coolness associated with forced air heating AND improper radiant panel placement. It should be clear from the above, how the *"radiant envelop"* concept works to improve energy efficiency and comfort!

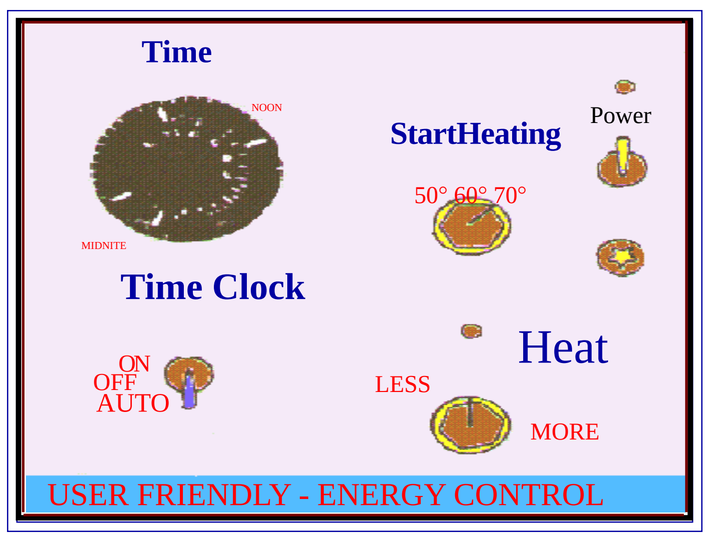
AND –

The ASHRAE formula for predicting annualized energy costs is: **BTU** loss **x D**egree **D**ays **x** Hours of use **divided by T**emperature **D**ifference(location area in US.)**x** a fuel efficiency factor **x** a B.T.U. energy unit factor **=** quantity of fuel **x** fuel cost = annualizeD fuel costs.

BUT... The entire formula hinges on the effective use of the fuel source!

ASHRAE gives specific points for the management process - if fuel efficiency is to be realized, exact control is imperative! The more effective use of a fuel - the lower the energy consumption & demand usage -lower fuel cost!

ASHRAE guidelines require that an energy management program must eliminate heating wastes caused by: **a)**overheating, especially in the mild temperature days, **b)** oversized heating equipment, **c)** thermal and distance lag, and, **d)** responding quickly to changes in outdoor temperatures and compensate for the changes in structural heat loss.



That's It !

EXACT IMPLEMENTATION OF *HEAT SOURCE PLACEMENT* AND *ENERGY MANAGEMENT* MAKES THE RADIANT HEATING PROCESS WORK!

Let me include a few comments on what has been printed concerning ***HEAT PUMPS.*** I seem to be asked about this subject frequently, so let someone else do the talking. →

What services do you provide to make my project successful?

Radiant Systems has been designing radiant heating projects for 25 +years. Most included air conditioning and exchange air ventilation to satisfy local building codes and owner requests. Commercial installations include apartments, motels, hotels, hospitals, nursing homes, assisted living residences, gymnasiums, churches, schools, multi-purpose rooms, teaching stations, camp buildings, service garages, auto and woodworking shops, indoor swimming pools, dozens of "add to" or supplemental heating to uncomfortable areas, and residential homes from 1,500 to over 12,000 square feet. Few if anyone else, in the radiant business has had the opportunity to successfully design, implement, and complete such a listing of projects.

The ultimate success of your project and the continuous year to year operation with efficient energy usage and low maintenance, lies in applying the following to the design process; **1)** accurately calculating structural heat loss factors as related to the specific localized temperature characteristics**,** **2)** selecting specifically, the right products appropriate to the architectural uniqueness of the structure, **3)** selective placement and installation of correctly sized equipment for reduction of energy wastes and for eliminating the poor comfort quality, and **4)** circuiting the electrical design to avoid excessive hardware and installation costs. Balancing these factors through our field installation experience, assures you an indoor environment of comfort, energy efficient and still remain responsibly cost-effective!

As we have stated before, **the key ingredient** for the success of the commercial or residential installations is the energy management control product developed by a team of engineers. From the comprehensive field performance testing and actual recorded data of maintenance and energy performance, this energy management system is unbeatable and unlike anything else available on the market! Radiant heating **is** definitely an energy saver, as recorded in many ASHRAE articles and is proven to be **the** most comfortable and maintenance free system available, **F**or consistently high performance of energy efficient comfort, the process necessitates the inclusion of this **energy control system!**

If you are a designer, architect, a specifying engineer, or a home owner and feel that radiant heating could possibly advance your project goals, then I will assist you wherever necessary to correctly analyze and implement this process, using high quality, durable products with the energy management control system. My services extend from the design, into the bidding, construction, including making accurate electrical drawings for your contractor to use on the job, and punch out phases of your project with NO added cost to you! I will do whatever is needed to see that your project is successful. In the past, I have worked closely with owners, decorators, and builders to assure proper product selection, installation locations, system calibration and performance.

Let's share ideas for your next project:

By Mail: Box 797/ Worthington, Ohio 43085
Call anytime: 877-885-1189 (toll-free)
Or by e-mail: radsysjed@sprintmail.com

Let me include a few comments on what has been printed concerning ***HEAT PUMPS.*** I seem to be asked about this subject frequently, so let someone else do the talking.

Heat Pumps vs. properly controlled Radiant Heat Systems

Recent articles have appeared in various publications, that report the "unbelieveable" energy results from some newly discovered heating processes. These heating processes are not new inventions, but recently discovered by the writer, who after contacting a product supplier, is convinced that this "new" heating process is the greatest energy saving heating program available. Interesting as these reports appear, I would like to illustrate that their "newness" and their "uniqueness" has been analysed before and as compared to the radiant heating process, fall short in fulfilling the desired goal of comfortable, energy efficient heating.

Heat pumps (air to air ***or*** water to air),even the "latest improved" ones, are *cool* heating, energy users (no one ever uses them in the winter without using lots of auxiliary heat), and definitely are a maintenance problem to owners. Two misconceptions commonly believed true, 1) they have greatly been improved over the years, and 2) you can use the heat pump without auxiliary heaters well below the published balance point. Under examination - 1) ask almost any owner - simple but true, they have frequent service calls and have replaced the entire heat pump unit in 7-9 years. 2) yes - you definitely can use the heat pump below the balance point, but a) occupants are always feeling cold, and b) you reduce the life of the heat pump drastically.

Let's examine some data on what recent research has revealed in an area that has been advertised frequently and aggressively by manufacturers and utility companies in regard to the performance of HEAT PUMPS.

Air source heat pumps

These products have been around for 30+ years. The theory behind the heat pump process is simply, extracting the warmth or coolness from the surounding air, can be used to heat or cool an area with little electrical energy consumption. However, through long hours of trial and error, there has been little improvement in heat pump efficiency and there still remain the same difficulties that existed in the original products - the heat is "cool" and uncomfortable, the maintenance is a real expense factor, longevity of the product is relatively short - all this and heat pumps save very little energy. The product has cost the manufacturers and utility companies BIG dollars and the results have been poor for the investment. The public's image of heat pumps has not changed - poor comfort and big maintenance.
They probably will continue to be perceived as a poor comfort and big maintenance product for many years.

Mr. Hank Ruthowski, a technical consultant with the Air Conditioning Contractors of America, wrote this; "During the heating season, air source heat pump owners may complain about cold supply air temperatures - or about cold drafts." ... "During heating, the temperature of the supply air that is delivered by an air source heat pump becomes cooler when the indoor air coil gets cooler as the outdoor temperature drops. It is normal for this supply air temperature to fall below 85°, and it can even fall below 80°. When the auxiliary heat is energized, the supply air temperature may range from 90° to 105°, or more depending on the outdoor temperature - and on how much auxiliary heat capacity (KW) is activated. The warmer supply air temperature produced when the auxiliary coils are activated are more desirable, but this operating condition may last just a few minutes out of each hour. Excessive KW produces shorter periods of operation with warm supply temperatures and longer periods of operation with cool supply temperatures." To simplify, **with heat pumps - you get what you pay for**; periods of economic, uncomfortable coolness **or** periods of expensive moderately warm comfort. Mr. Skip Krepcik, writing in the Air Conditioning, Heating & Refrigeration News wrote, "Satisfying consumers with the cost of operating an air to air heat pump has usually been easier than satisfying their demands for comfort. This is particularly true when the outdoor ambient tremperature approaches the balance point."... "Most complaints about comfort begin as the weather approaches the balance point conditions and 'cooler' warm air is circulated. A 5° to 10°F change in measured supply air temperature can make a big difference in perceived temperature - and that abstract concept called comfort." The long and the short of it, *Skip*, comfort is **not** an abstraction, but well defined in ASHRAE, however heat pump heating can not possibly address the requirements successfully! . The air is simply too cool for comfort under every heating condition and the air movement from the fan makes the situation even worse. *Heat pump air temperature warmth is always a form of concession to the comfort level desired by users for an ideal indoor climate environment.*

Water source heat pumps

An explanation of the closed loop version, a continuous predetermined loop enclosed under the ground, filled with a liquid, **vs.** the open loop system, heat pump connected to a well. Within the city limits there needs to be an "in" water well and an "out" - two wells (more costly) to satisfy codes.

As example of many others,an article in the Sunday, June 13,1999,*Columbus Dispatch*, Home & Garden section has interesting observations from water source heat pump owners and installers. Quoting from the article will give us the answers we are looking for.

Let's examine the economic realities from this article.

Example A, is a private residence outside of the city limits; "Through investigation and negotiating, they learned they could put in a geothermal system for $15,000.00 IF they did some of the work themselves."... "They ESTIMATED they would save hundreds of dollars with geothermal energy, with yearly costs (heat) averaging $651.00 for geothermal, $1,449.00 for electric (heat pump - air to air with auxiliary strips) and $1,550.0 with propane."... "So far, the electric bills for the 3,150 sq.ft. house in the coldest months have been about $160.00 a month... in the winter and $90.00 a month in the non-heating (or cooling) months." NOW, let's see how good, good really is as we look at the actual dollars per sq.ft. basis. $160.00 x 5 = $800.00 + $90.00 x 7 = $630.00. Adding to a total of $2,230.00 divided by 3,150 sq.ft. = $.70 cents per sq.ft. per year. Not too good for inexpensive heating, that will need expensive equipment servicing on a regular basis and replacement within 10 years. I need to add that the installer is a very professional person, and considered one of the best in his field. The installation, knowing this individual's work, accounts for the success these owners are experiencing. BUT, what if the owner selects a lesser installer.

Example B, is another residence within the city limits. The owners decided to try geothermal for an old furnace replacement option. The system cost of $10,000.00 was twice the cost of installing a gas furnace. "From the beginning the geothermal system, 'was an adventure.' " ... An inexperienced installer projected the installation of 4 days. It took 6 weeks. Pipe replacement was required since the installer chose wrong. " They had to redig the wells (note: city, 2 wells) to pack the earth tighter around the pipes." Mrs. doesn't talk about cost savings, because there is little, if any, but she does report, "But it makes me really happy to have a combustion-free home." Energy cost - $170.00 x 5 = $850.00 + $80.00 x 7 = 560 totaling $1,410..00. The sq.footage of the home is not given, but in that local 2,000 sq.ft. would be an average -SO, $.70 cent per sq.ft.,again **NOT** what one would call energy efficient. The high maintenance and replacement issues to be addressed sooner or later by the owners, IF nothing more disastrous happens to add cost to the installation.

This is a great article and states it like it is - heat pumps required auxiliary heat to do the job and the energy cost is big. The above energy reports are from some of the warmest winters in recorded history for this area -wait until the winters are colder and owners are less inclined to rely on "cool" heat pump comfort and use more of those auxiliary heaters.

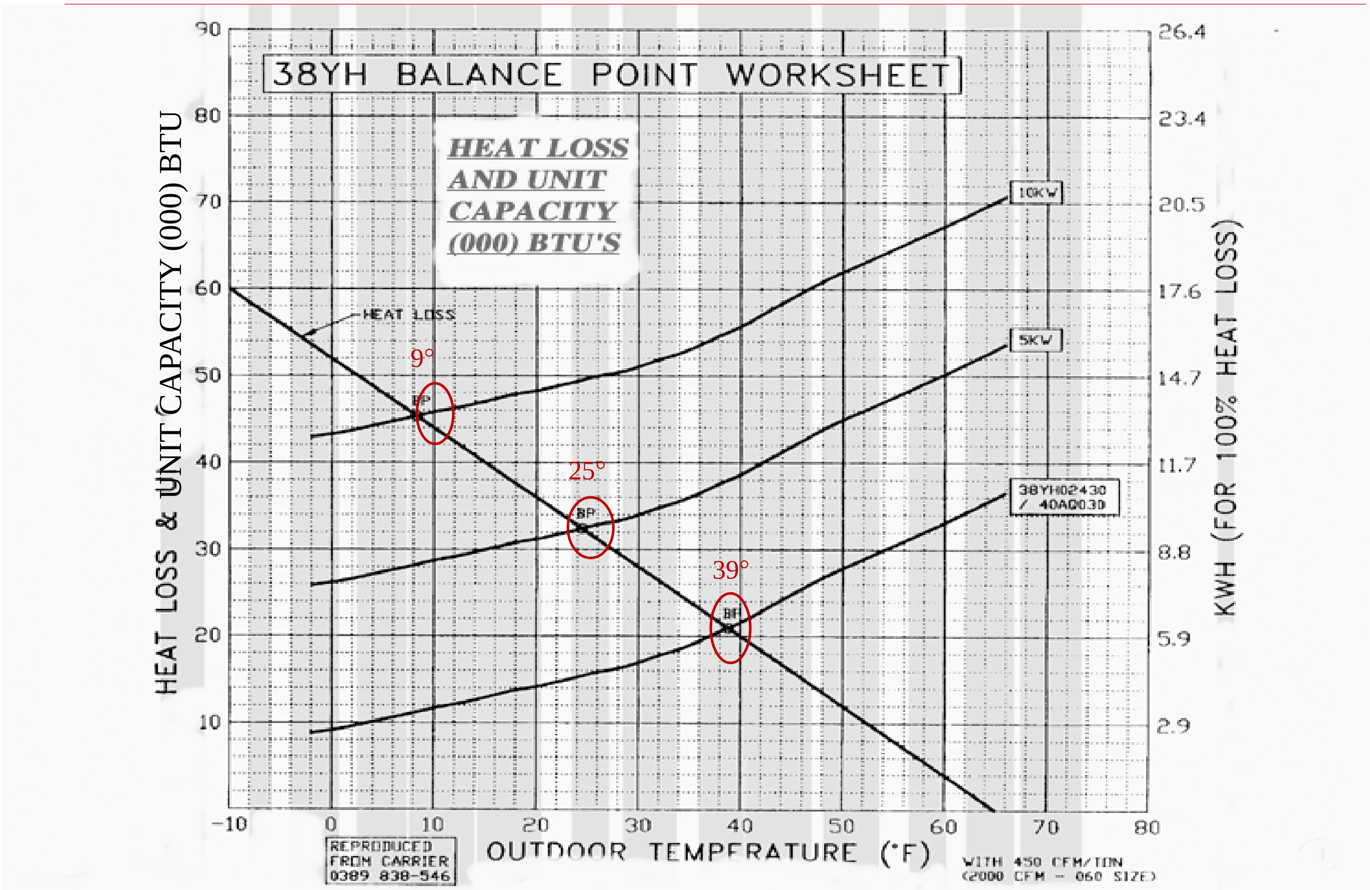
AGAIN - "Ashrae standards define thermal comfort as the state of mind that expresses satisfaction with the thermal environment. Occupant thermal comfort is an essential condition of any heating system." .. "The consensus of human thermal comfort studies is that human thermal comfort is a function of: 1) air temperature, 2) mean radiant temperature, 3) air velocity, 4) relative humidity, 5) clothing, and 6) activity level." Further in the equation; "The *mean radiant temperature* is defined as the uniform temperature... in which the radiation from the occupant equals the radiant transfer" of the radiating heating source. We are comfortable if everything is balanced correctly!

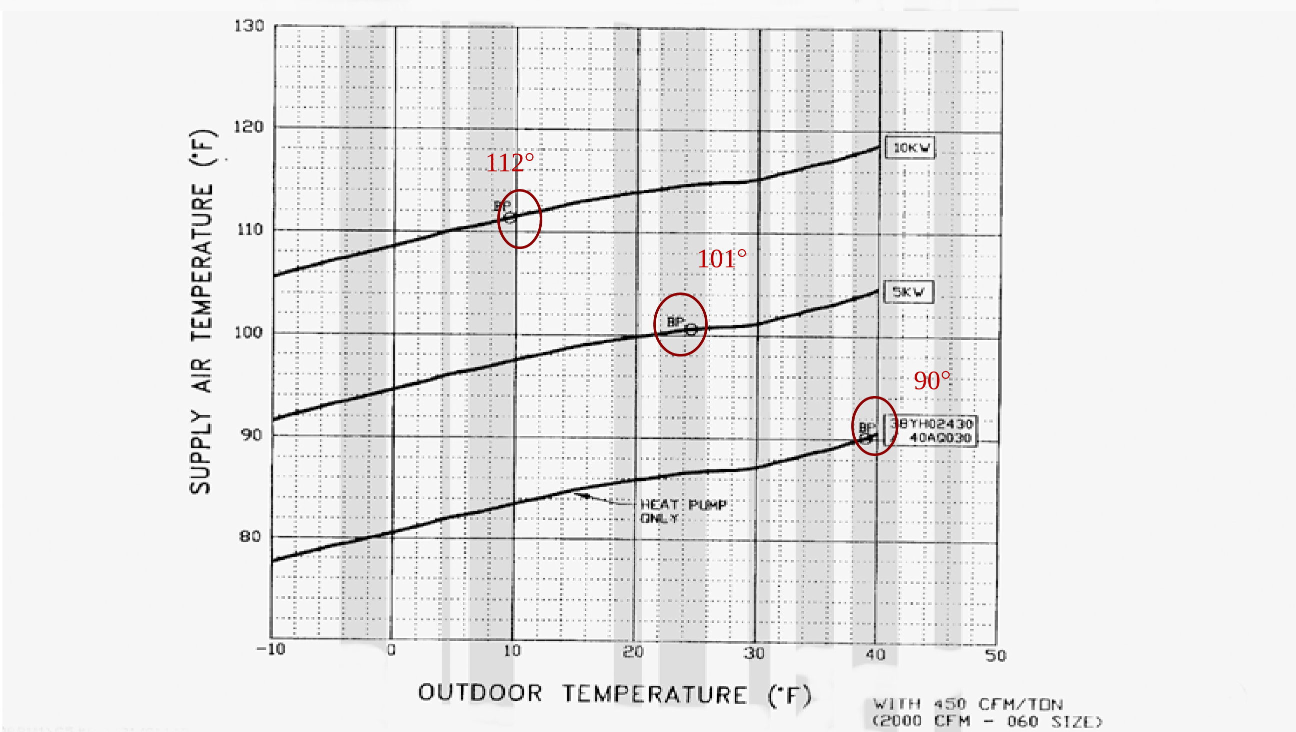
The term *balance point* explains it. It applies to air source and water source heat pumps and is the calculated point **where unit performance and people comfort meet**, Without additional auxiliary heating in the ducts, comfort is definitely sacrificed below this point. This is why heat pumps use lots of energy in cold climates.Water source heat pumps use less energy, since the water remains close to 50°, where the air source can be much lower. BUT, they all require the use of auxiliary resistance heat for comfort below an outdoor temperature of 35°. Owners that do not use the booster heat, greatly reduce the life of the heat pump.

Let's look at some actual heat pump tables

These tables are for a 2.5 ton unit/1,500 sq.ft. home. Quantity of supplementary heat greatly increases as home size and heat loss increases.

As the outdoor temperature decreases, the heat loss of the structure is greater and the balance point for heat pump comfort necessitates additional heat strip assistance.





These are not very comfortable temperature levels, especially when you reduce the comfort factor because of the blowing air from the fan.

BUT - Gas or oil air temperatures at the duct, usually approach 106° + degrees, therefore people, especially women, enjoy MUCH warmer air temperatures than available with heat pumps, even when using the auxiliary heating strips - resulting in much higher operational cost and rewarding the user with far less comfort.

ACCA, Air Conditioning Contractors of America, technical bulletins reference the "cool" comfort problem constantly. This is the most prevalent issue troubling commercial and residential owners, even more prevalent than the almost "given" issue of equipment maintnenance and replacement. #84 as an example of many, " During the heating season, heat pump owners may complain about cold supply air temperatures,... The warmer supply air temperature produced when the auxiliary coils are active are more desirable, but this operating condition may last just a few minutes out of each hour. Excessive KW produces shorter periods of operation with warm supply temperatures and longer periods of operation with cool supply temperatures."..."Heat pumps are not designed to be used as hand or foot warmers.The airflow near the supply outlets will **always feel cool**."

'ALWAYS FEEL COOL' - all winter ? - GREAT!

Radiant heating system with energy controls

Recalling some of the experiences of our clients, operational costs were below those reported by those using water source heat pumps. The air source heat pumps are not a real consideration, since ASHRAE and local utility companies have documented, which means actual monthly billing statements, comparing the air type heat pumps to a radiant heating system, managed by our control system. A) The example using radiant heat and the energy management controller, was a 4,200 sq.ft. home with a monthly electrical budget of $155.00 x 12 = $1,860.00 divided by 4,200 sq.ft. = $.. 44 cents for total energy (all electric except hot water) per sq.f.t./year. If one substracts the off-heating monthly cost of $80.00, the remaining $75.00 (155-80=75) is for heating, therefore $75.00 x 12 = $900.00 heat cost/year or $900 divided by 4,200 = $. 22 cents sq.ft. for heating - NOW *that is what I call good*! The added features of no drafts and no temperature variation, clean indoor air quality,individual room temperature control + no maintenance in 20 years, makes this example a good comparison to ANY heating system.. Example B, a 9,000 sq.f.t. home with a 2,500 sq.ft. swimming pool kept at 80° all year, has documented evidence that total energy per sq.ft./year is $. 62 cents. No way to extract heat costs, since these people air condition all summer + 3 Water heaters. Is that good? Again, no maintenance for over 20 years.

The radiant panel process, controlled with our energy management system controller, will provide constant comfort & energy efficiency without costly maintenance or replacement concerns. LET US LOOK OVER YOUR PLANS AND WE WILL BE GLAD TO SHARE SOME IDEAS WITH YOU ON COMFORT AND ENERGY EFFICIENCY THAT IS BASED UPON OUR YEARS OF EXPERIENCE WITH PRODUCT INSTALLATION AND DESIGN.

Thanks for taking the time to think with us!

Please write us / Box 797-Worthington, Ohio 43085 or call / 877-885-1189 and we would be pleased to share some ideas with you for your home or your next project. Jim Dawson